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Agricultural Feedstocks for Renewable Energy Technologies

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Benefits of Integrating Agricultural Feedstock into energy production

- Reduced environmental foot print of petroleum fuels
- Reduced environmental impact of intensive agriculture
- Food and energy security
- Build a bridge between rural and urban economy

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Evolution of Feedstock Utilization

- Agricultural “Waste” (Manure/Crop residue)
  - Solve environmental problem
  - Biofuel by-product
- Competing-use Crops with Economically Viable Co-products
  - Synergy with food production
  - Biofuel Integration
- Dedicated Energy Crops (Cellulosic & Biotech Barriers)
  - Biofuel focused
  - Petroleum replacement

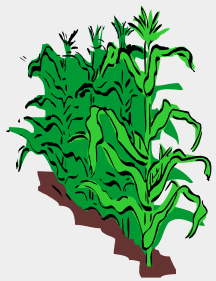
Biofuel Feedstock from Plant and Animal Material

Manure from CAFO's & Crop residues

- Biogas, Biomethane, Hydrogen

Animal & Vegetable Oils

- Biodiesel



Cereal Grains & Sugar Crops

- Ethanol

Almost all biofuel production is out of state/out of US

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Manure from Confined Animal Feeding Operations

- 1,900 Dairies
- 1.8 Million Cows
- Central Valley concentration
- 65 Billion lbs Manure
- Most energy value currently wasted

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Potential Dairy Methane Production from CA Dairies

Type of Dairies	Number of Cows	Potential Daily Methane Production [b] (ft^3/d)	
		Per Cow [c]	In California
Flushed freestall	595,769	32.2	19,183,771
Scraped freestall	170,220	32.2	5,481,084
Flushed drylot	510,659	23.8	12,153,691
Scraped drylot [d]	425,550	5.6	2,383,080
Totals	1,702,198		39,201,626

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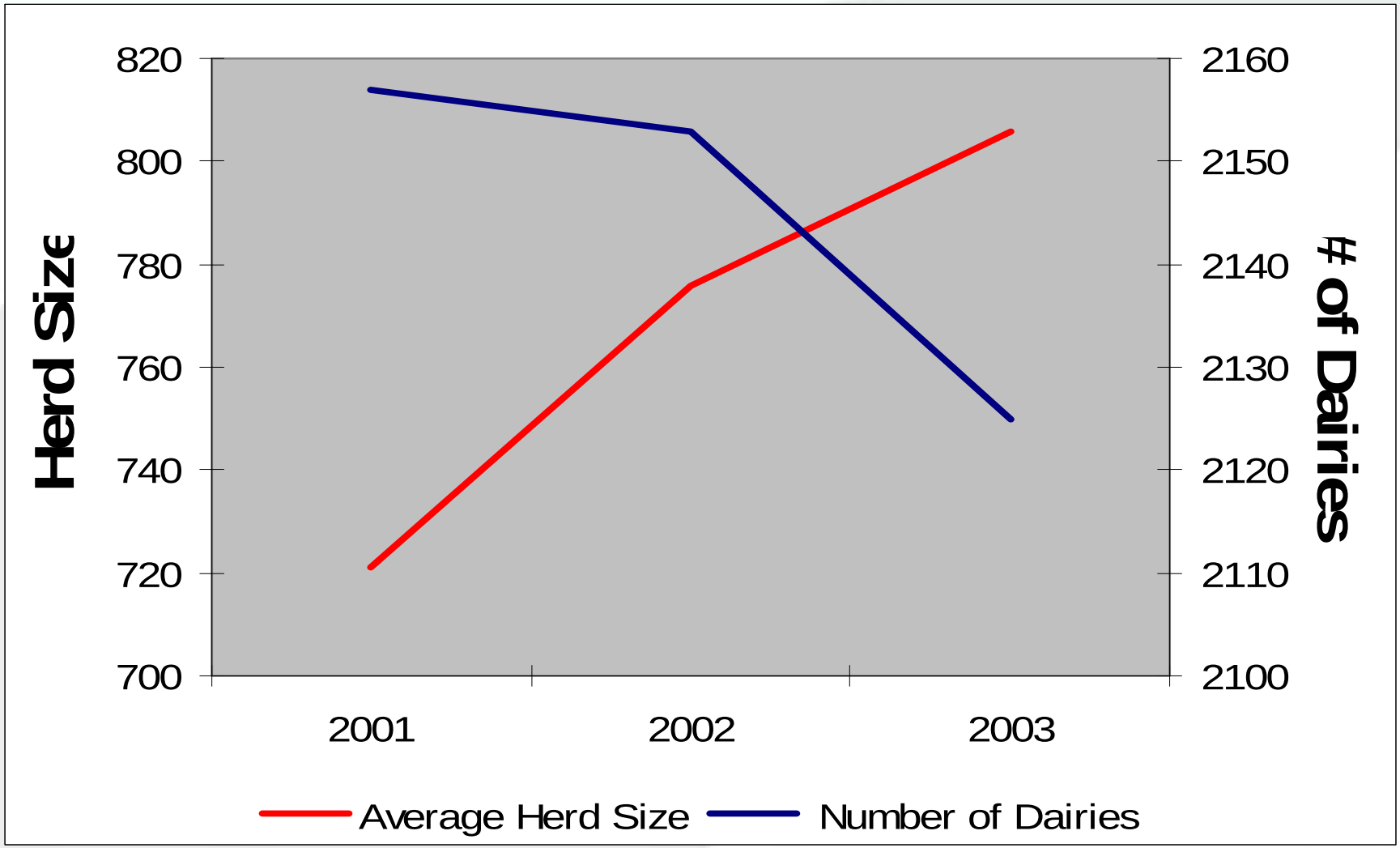
Energy potential of CA Dairies

- 40 Million ft^3/day (14.6 Billion ft^3/year)
- $146 million/year in natural gas value
- 1.2 Million MWh Electrical energy

Dairy Industry Trends



Dairy Environmental Concerns

- Air Emissions: Reducing VOC, PM and potentially Ammonia Emissions
  - Digesters as control technology
- Water Pollution: Balancing manure land application with crop uptake
  - Regional clusters with excess manure

Status of Technologies for Dairies

- Anaerobic Digestion
  - Approx. 12 digesters working on CA dairies
  - Produces couple megawatts of electricity
- Gasification
  - Pilot projects currently being developed
  - Volume reduction – easier to transport ash off farm than raw manure
  - Emissions and fate of nitrogen?

Biomethane: What Next?

- Upgrade biogas to biomethane fuel
- Sweden is using as a fuel now
- Enough biogas to easily run all natural gas powered vehicles in CA.
- Bridge to the H2 highway?

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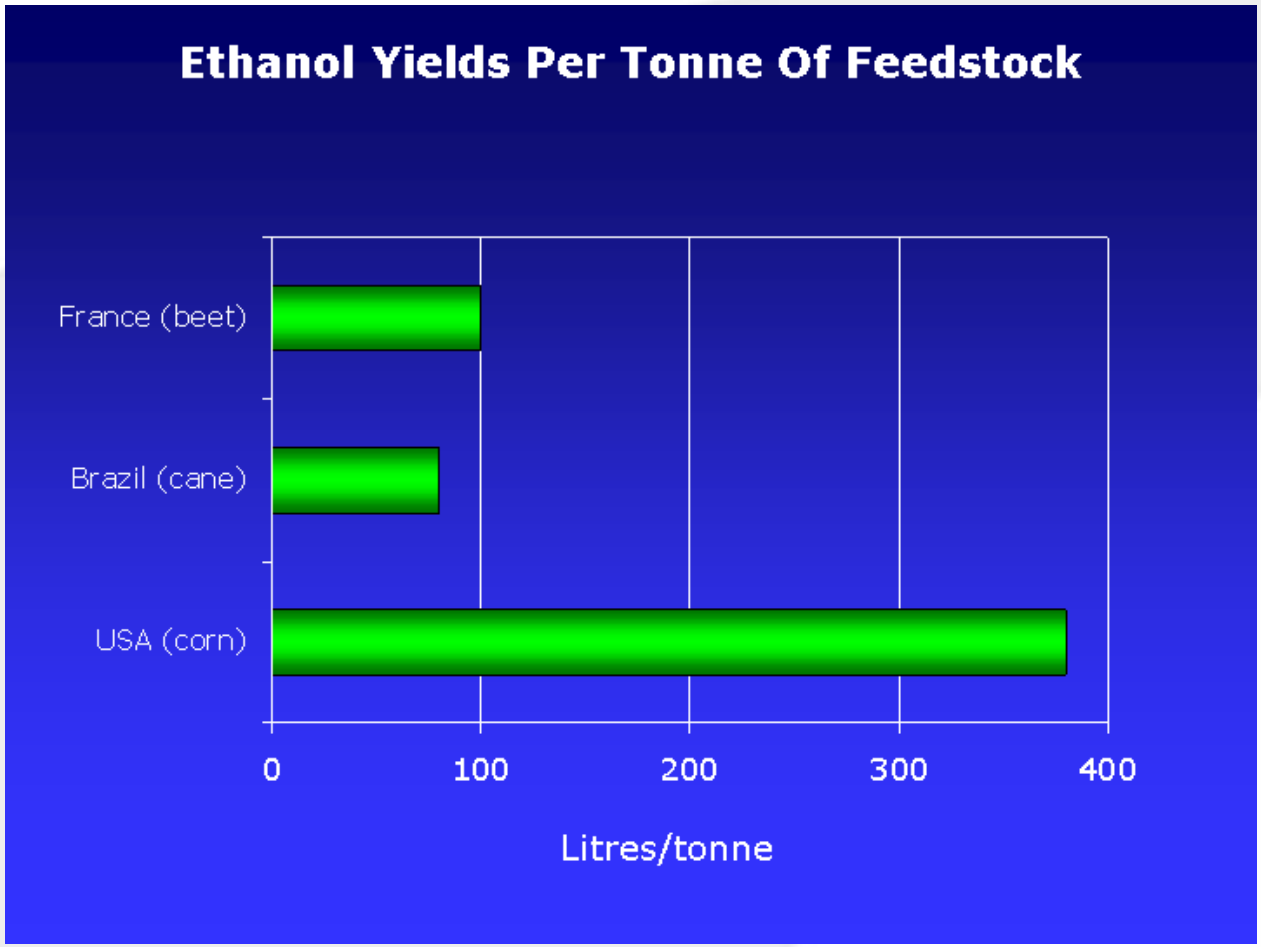
Cereal Grains and Sugar Crops

- Primary biofuel is Ethanol
- Can be produced from any starch or sugar crop
- Brazil produced 4 billion gals from sugar cane
- U.S. produced 3.5 billion gals from Mid-West Corn
- CA consumes over 900 million gallons
- Only One ethanol plant in CA
- 12% of automotive fuel has some ethanol

Leading Ethanol Feedstock Yield



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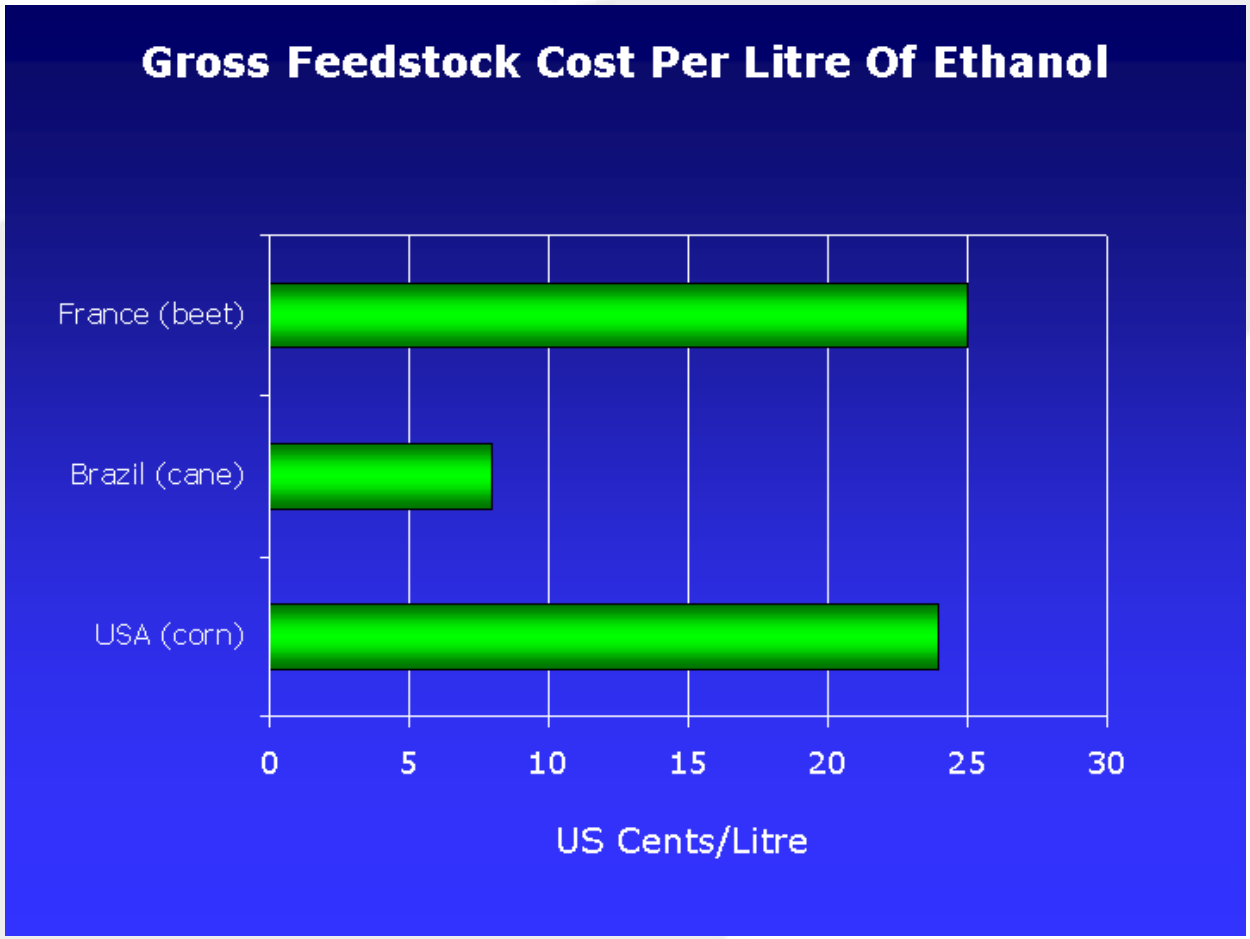
Why Brazil is World Leader



Ethanol: Key Issues

- Energy yield from corn is problematic
- Environmental impacts from corn
- Ethanol can be made from other crops
- Can we produce it in CA?

Integrating Biofuels into CA Agriculture

Corn

↓

Ethanol

↓

Wet Distillers Grains

↓

Cows

↓

Corn

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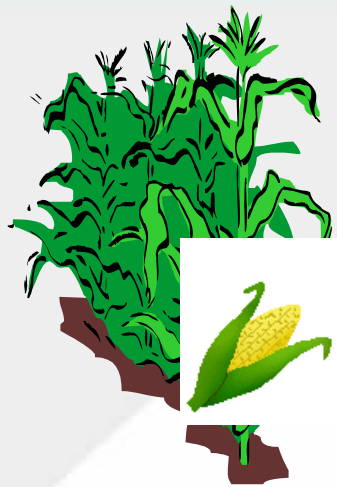
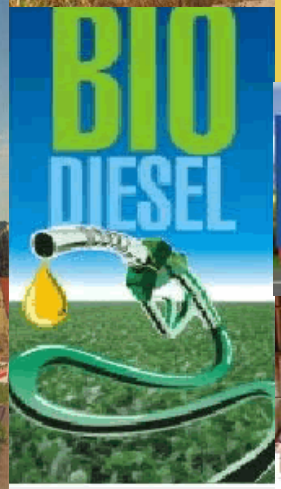
Ethanol: What Next?



- Air issues as barriers?
- Eco-friendly farming in CA?
- Cellulosic vs corn ethanol?
- Renewable Fuels Standard


AVIA
Benzin bleifrei 186.9
Super bleifrei 191.9
Super Plus 196.9
Diesel 147.9
Bio Diesel 137.9
Snack's & Shoping


BIO
DIESEL


UNLEADED
WITH ETHANOL
89


BIODIESEL
www.biodiesel.de
Schont unsere Umwelt.

Benefits of Biodiesel

- Reduction in nearly all forms of air pollution
- Reduction in GHG's
- Positive energy balance (3.2:1)
- Non-toxic and biodegradable
- Can be used in existing diesel engines

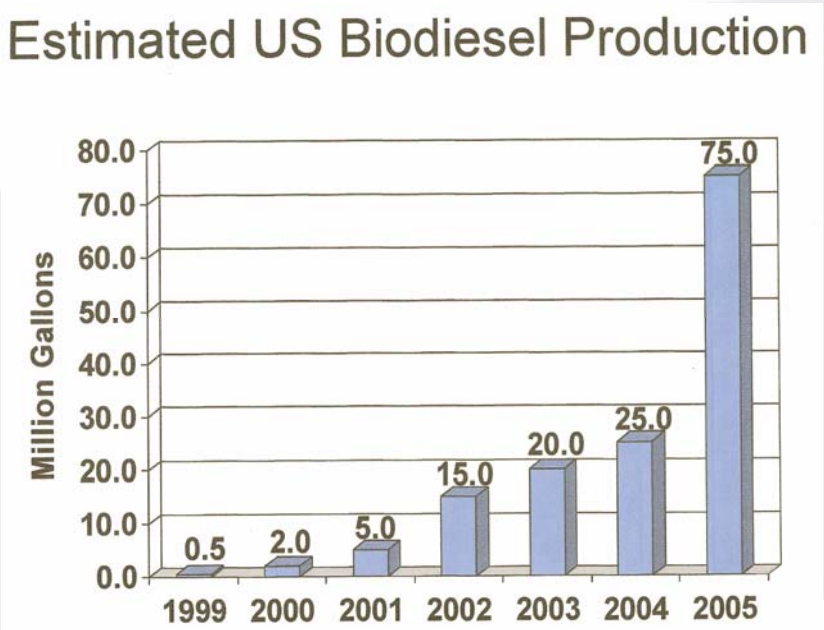
Animal and Vegetable Oil Sources

100 lbs of oil + 10 lbs of methanol = 100 lbs of biodiesel + 10 lbs of glycerol

Vegetable Oil Production (Billion pounds/yr)	
Soybean	18.34
Peanuts	0.22
Sunflower	1.00
Cottonseed	1.01
Corn	2.42
Others	0.67
Total Veg. Oil	**23.66**

Animal Fats (Billion pounds/yr)	
Edible Tallow	1.63
Inedible tallow	3.86
Lard & Grease	1.31
Yellow Grease	2.63
Poultry Fat	2.22
Total Animal Fat	**11.64**

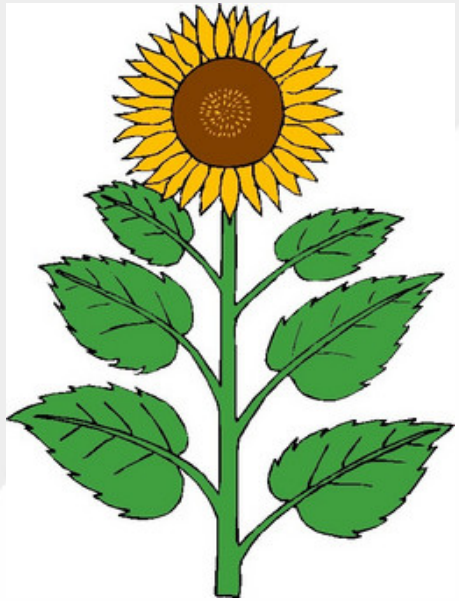
Animal and Vegetable Oils for Biodiesel feedstock



CA					
E	American Biofuels LLC	Bakersfield	5,000,000	Soybean Oil	Jun-06
	Bay Biodiesel, LLC	Martinez	2,500,000	Soybean Oil	Jan-06
	LC Biofuels	Richmond	350,000	Yellow Grease	Mar-06
	Simple Fuels LLC	Vinton		Recycled Cooking Oil	Feb-07

Biodiesel: What Next?

- CA based production
  - What crops?
  - How to make eco-friendly?
- What does it take?
- Primary market incentives?
- What blend and when?



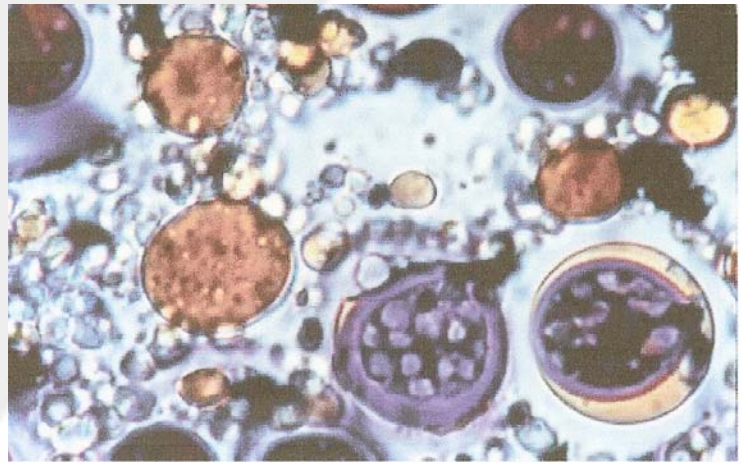
The future of Feedstock

Jatropha (Biodiesel - 175 gal/Acre vs. 45 Gal/Acre for Soybean

Algaculture

(Biodiesel 5,000-20,000 gal/Acre)

Hydrogen Production



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Where we go from here…

- Biofuels can be part of CA's energy solutions
- Biofuels are not zero impact solution
- Production is almost non-existent in CA
- Partnership between environmentalist and agriculture would be powerful alliance
- Need to validate environmental risks and benefits

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